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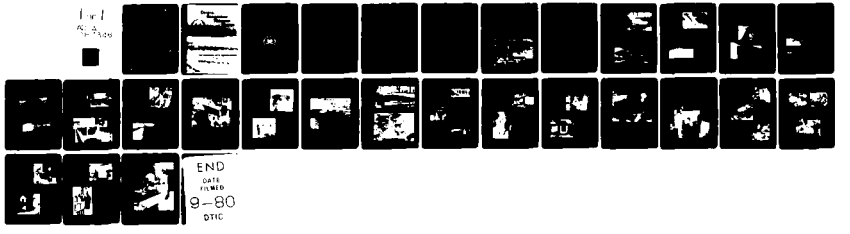

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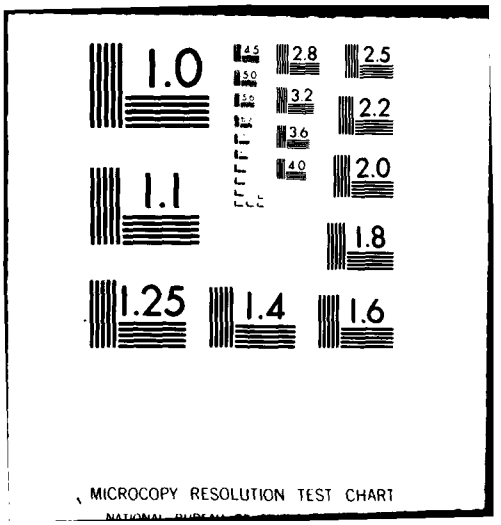
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The Coastal Engineering Research Center (CERC) is one of five laboratories and research centers of the U.S. Army Corps of Engineers. This publication describes CERC's mission, capabilities, and facilities.

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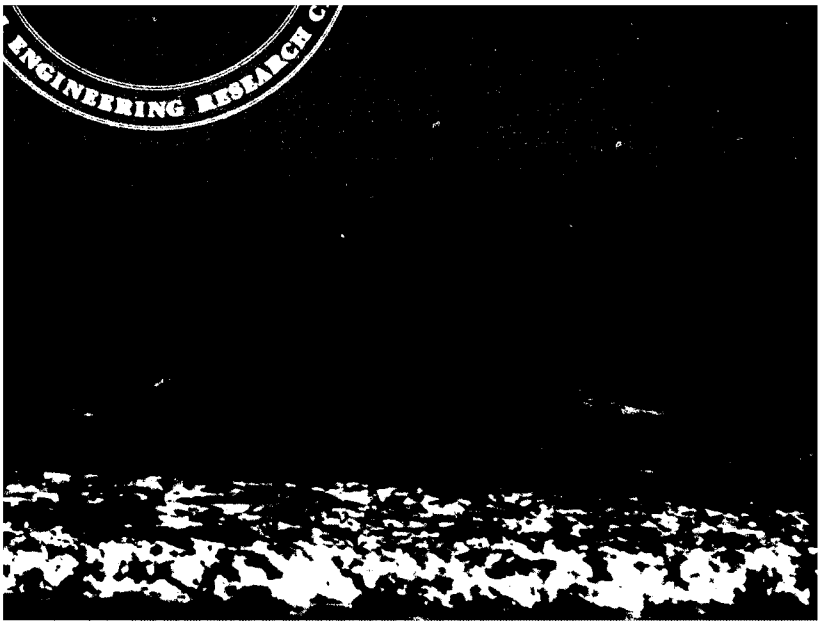

ENGINEERING RESEARCH

Coastal Engineering Research Center

ITS MISSION AND CAPABILITIES

MAY 1980

U.S. ARMY, CORPS OF ENGINEERS
COASTAL ENGINEERING
RESEARCH CENTER
Kingman Building
Fort Belvoir, Va. 22060

PREFACE

The Coastal Engineering Research Center (CERC) is one of five major laboratories and research centers of the U.S. Army Corps of Engineers. This publication describes CERC's mission, capabilities, and facilities.

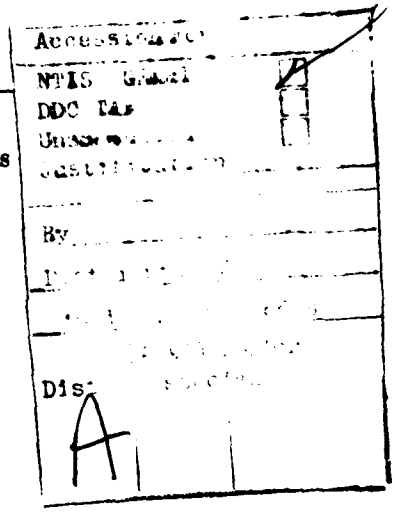
The Corps of Engineers is responsible for a wide range of civil and military missions. In its military missions, the Corps acts as a combat arm of the U.S. Army and as a principal combat support component. The civil works mission serves a dual purpose of developing the nation's water resources while keeping the Corps ready to respond to national emergencies with state-of-the-art civil engineering. The civil works research and development program is directed toward improving the Corps of Engineers' capability to combine an effective, economical water resources mission and program with environmental protection and safety. The program addresses problems encountered in accomplishing the present civil works goals as well as problems foreseen in providing for the needs of the future. CERC supports this mission of the Corps with research and development in the field of coastal engineering.

The publication was prepared by the Coastal Engineering Information and Analysis Center (CEIAC), under the general supervision of Dennis W. Berg, Chief, Technical Information Division. Thorndike Saville, Jr., was Technical Director of CERC.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director



CONTENTS

COASTAL ENGINEERING RESEARCH CENTER
ITS MISSION AND CAPABILITIES

by
Andre Szuwalski and Linda Clark

INTRODUCTION

The Coastal Engineering Research Center (CERC) is the principal research and development facility of the U.S. Army Corps of Engineers in the field of coastal engineering, with application to Corps missions in shore and beach erosion control; coastal flood and storm protection; recreation; navigation improvement; and the location, layout, design and construction, operation, and maintenance of harbors. The program encompasses the disciplinary areas of Coastal Hydraulics, Coastal Sediments, Coastal Structures, and Coastal Ecology and their interrelationships. CERC's research and development program is aimed at developing relationships and guidelines which can be used to arrive at effective solutions to real coastal engineering problems. The mission of CERC is to conceive, plan, and conduct research and data collection in coastal engineering and nearshore oceanography to:

(1) Provide a better understanding of the littoral forces (winds, waves, tides, and currents) and the resultant coastal processes, and the interaction of these forces and processes with shores and beaches, coastal and offshore structures, and the materials forming these shores, beaches, and structures;

(2) determine scientific engineering data and design criteria; and

(3) determine the effects of the Corps' engineering activities on the ecology of the coastal zone.

The results of research conducted at CERC are published for use by the Corps of Engineers and the public. In addition to research, CERC provides consulting services in coastal engineering to the Corps of Engineers and other public agencies as requested or directed:

(1) On the planning and design of coastal and offshore works.

(2) On coastal and nearshore phenomena and related engineering and environmental problems.

(3) By reviewing studies, and plans and specifications for coastal and offshore engineering works.

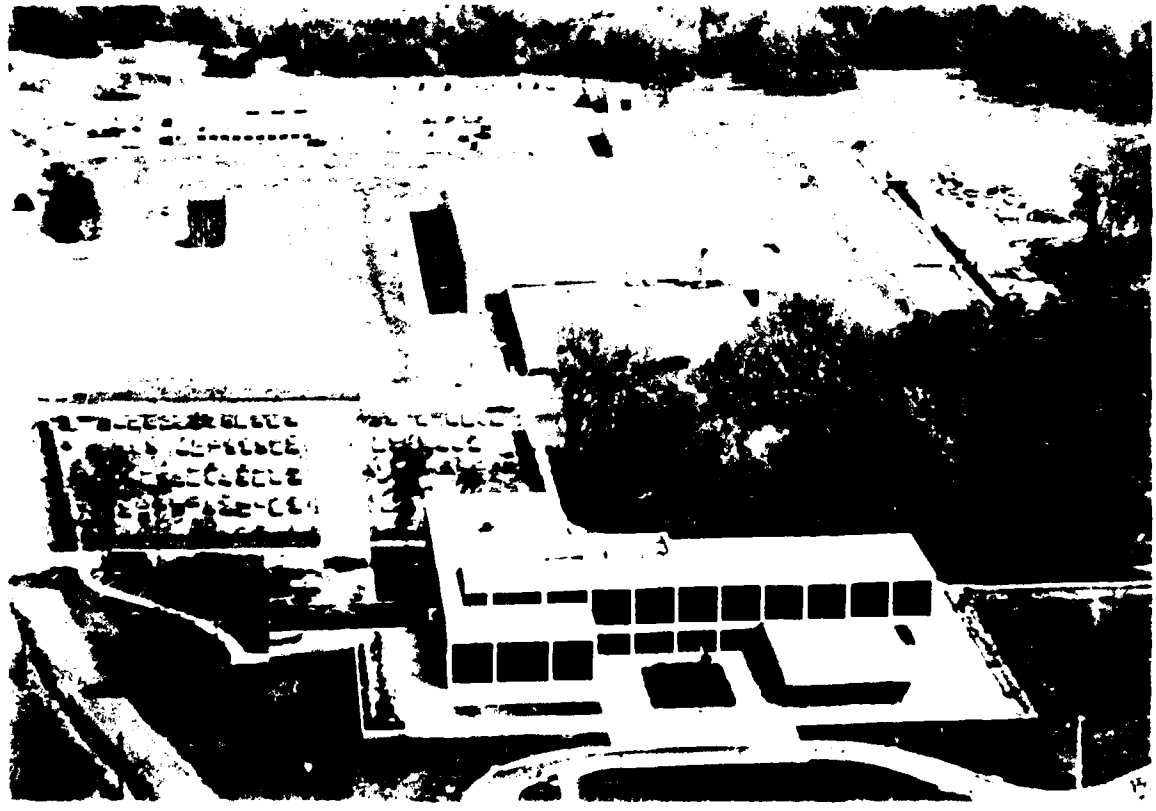
CERC also operates the Department of Defense Coastal Engineering Information and Analysis Center.

LOCATION

In May 1973, CERC moved to its present location in the northern corner of the Fort Belvoir Military Reservation, south of Alexandria, Virginia. CERC's offices are located in the Kingman Building on Leaf Road about 0.2 mile from its intersection with Telegraph Road. The Jay V. Hall, Jr. Laboratory building which houses CERC's laboratory research facilities is located directly behind the Kingman Building. CERC also has a field research facility at Duck, North Carolina.

Visitors are welcome and guided tours can be arranged through the Public Affairs Office (202) 325-7386. The mailing address is:

Department of the Army
Coastal Engineering Research Center
Corps of Engineers
Kingman Building
Fort Belvoir, Virginia 22060



PERSONNEL RESOURCES

The Commander and Director and Deputy Commander and Director of the Coastal Engineering Research Center are career officers of the Corps of Engineers who normally serve at CERC for 3 years. Continuity and technical expertise in the direction of the scientific and engineering program is provided by the Technical Director, a civilian employee. The civilian staff consists of about 160 employees of which about 60 are engineers and scientists, including hydraulic, civil and electronic engineers, ecologists, physical scientists, mathematicians, oceanographers, and geologists. Technicians and assistants, representing a broad range of specialized skills and knowledge, comprise another part of the staff. The technical capability is further enhanced by the services of leading consultants, on a contract basis, who are drawn from among recognized authorities at universities and in industrial professional life.

RESEARCH PROGRAM

Engineering research and development is a search for relationships, guidelines, and criteria which can be used for arriving at a solution that is functionally and structurally sound, environmentally acceptable, aesthetically pleasing, and economically justified.

CERC's coastal engineering research program is organized to pursue a logical path of investigation that will result in understanding and knowledge of the coastal zone and the processes affecting this zone, and their application to practical solutions. The program focuses on five areas of investigation:

WAVES AND COASTAL FLOODING
INLET AND ESTUARY CHANNELS
BEACH BEHAVIOR AND RESTORATION
COASTAL STRUCTURES
COASTAL ECOLOGY

Results of research in these areas will allow rational solutions to coastal engineering problems and will provide for the environmentally sound use of the coastal zone.

WAVES AND COASTAL FLOODING

This area of research develops field techniques and criteria for the consideration of waves, winds, tides, storm surges and tsunamis in coastal navigation and coastal flooding protection projects.

Prediction of flooding is required for coastal zone management.

Waves are both the most important force acting on beaches and coastlines, and the most damaging to coasts and coastal structures. Adequate knowledge for coastal zone management, and for design of coastal structures and projects requires an understanding of how the waves are generated, how they travel, how they change as they near the shore, how they break and dissipate, and how they attack the shore and structures on the shore. Also required is a knowledge of the frequency with which they may occur. The program also develops models for predicting coastal and inland flooding due to storms. This knowledge is then applied to design, operate, and maintain projects, both structural and nonstructural, to protect shores and ports.

Waves are the most important force acting on beaches.

INLET AND ESTUARY CHANNELS

This area of research develops field techniques and criteria for the design, construction, and maintenance of navigational channels through coastal inlets and estuaries.

Coastal inlet with dual jetties.

The program is concerned with the hydraulics of flow through coastal inlets, the sedimentary processes of inlets and adjacent areas, and the response of these inlets and adjacent areas to forces which form and modify them. One engineering technique improved by this program is the use of numerical modeling for the prediction of the hydraulic characteristics of tidal entrances. From this effort, criteria are developed which will allow the engineer to determine what effects constructing a new inlet, for example, will have on the adjacent shoreline.

Single-jettied inlet.

BEACH BEHAVIOR AND RESTORATION

This research program develops field techniques and criteria for use in the design, construction, and maintenance of effective beach and dune shore protection projects.

The program seeks to describe and predict the interactions between the materials that make up the coasts and the forces that act upon them, i.e., the waves, currents, tides, and winds. It is concerned with the movement of sediments at and near the shore. The questions addressed include: What causes sediment movement? How fast do sediments move? How do sediments move (onshore-offshore and alongshore)? Do sediments leave the littoral environment? How much sediment moves away from the shore during storms of given intensities?

Segment of shore being eroded by wave action.

Restored beach after placement of fill material.

This area of research also seeks to develop mathematical models that designers can use to determine how much sandfill is required to adequately protect a segment of shore for a certain timespan against the onslaught of the seas and how often additional fill will be required, as well as models to predict the effect of projects on adjacent shores.

COASTAL STRUCTURES

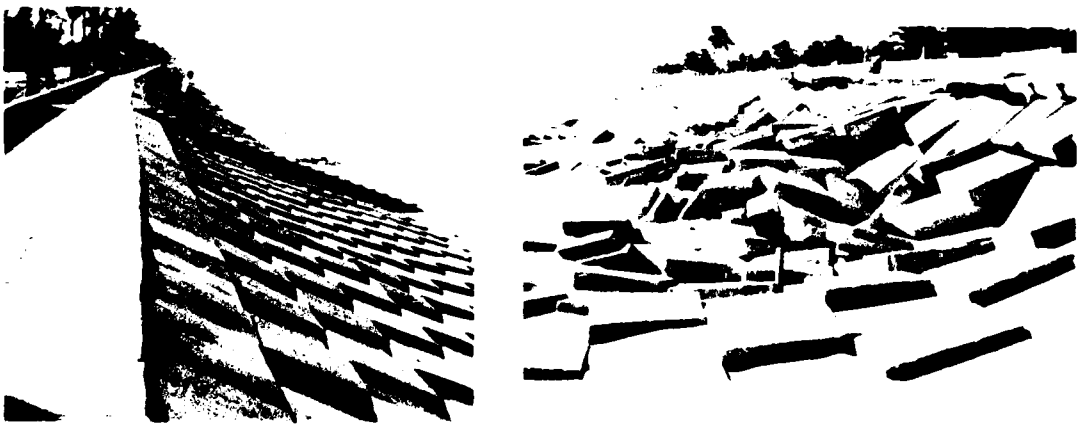
This area of research develops field techniques and criteria for the functional and structural design of effective coastal structures.

This program deals with the parameters which determine, for example: to what elevation must a groin be built to be effective; what must the slope of a revetment be to reduce wave runup; what size of armor stone in a breakwater is required against a wave of a certain height and period; to what depth of water must jetties be extended to provide safe navigation channels.

Seawall in San Francisco, California.

Groin system on Rockaway Beach, Long Island, New York.

Another facet of this program is the monitoring and evaluation of already constructed coastal structures and projects in terms of their effectiveness, maintenance cost, and life.



Concrete block revetment at Del Ray Beach, Florida.

COASTAL ECOLOGY

The ecological research program determines the ecological effects of the Corps' coastal engineering activities, to quantify them where possible, and to develop techniques and procedures which create or enhance desirable effects or mitigate undesirable ones. The program is conducted primarily in the field, and provides specific guidance for field personnel.

Beach grass used as an erosion control measure on Currituck Sound, Duck, North Carolina.

Major subjects covered by the present program are the ecological effects of coastal dredging, beach nourishment, coastal construction and coastal structures, and the engineering uses of vegetation in both structural and nonstructural approaches to coastal navigation, hurricane protection, and shore erosion projects.

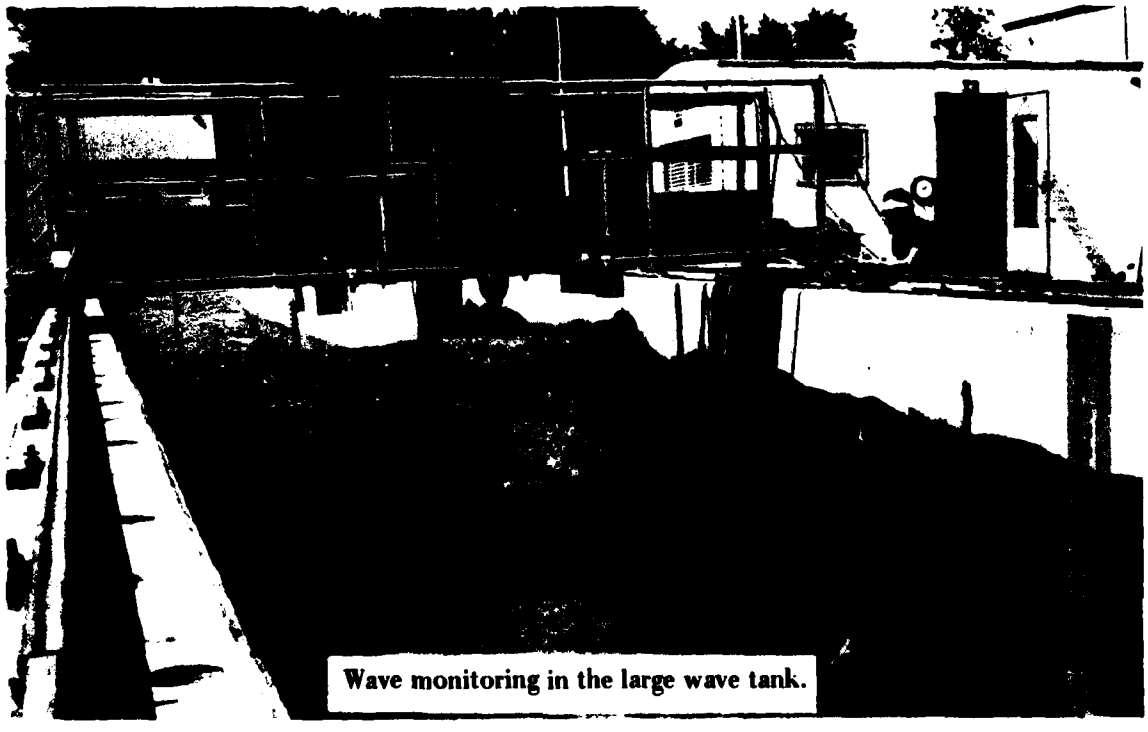
RESEARCH FACILITIES

LARGE WAVE TANK

This outdoor concrete wave tank is 635 feet long, 15 feet wide, and 20 feet deep, and can test with waves up to 6 feet in height. It is large enough to permit engineers and scientists to conduct two-dimensional experiments at scales up to prototype. Examples of the type of experiments conducted in this tank are:
(a) rate of erosion on a sand beach; (b) evaluation of hand-placed concrete block revetments as erosion protection for a sand beach; (c) evaluation of sandbag revetments as erosion protection for a sand bluff; (d) evaluation of floating tire breakwaters as energy absorbing devices; and (e) the collection of data for the safe and economical design of rubble-mound breakwaters.

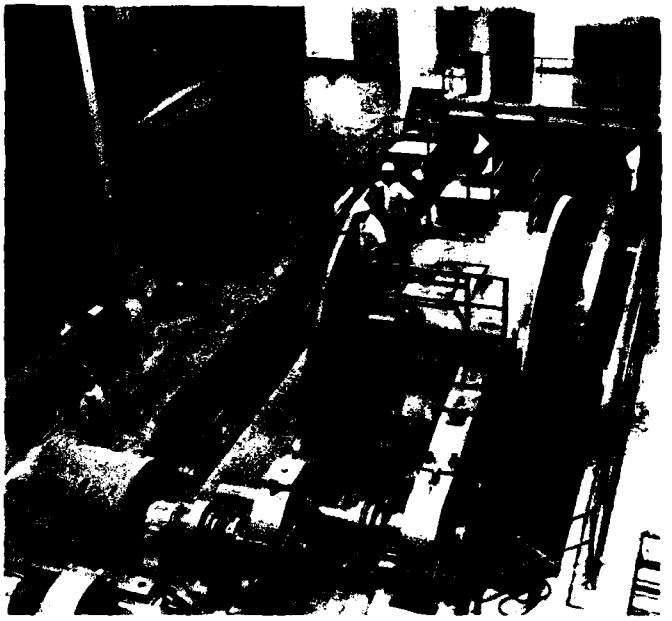
Tires being tested as a wave energy dissipator in the large wave tank.

The large wave tank has two manually operated instrument carriages that ride on rails mounted along the entire length of both side walls. These instrument carriages carry both personnel and instruments. Removable watertight bulkheads and seven sets of slots permit the tank to be partitioned into sections of various lengths. Underwater observations can be made through portholes located in a pit about midway along the tank.



Wave monitoring in the large wave tank.

The wave generator consists of a vertical bulkhead 15 feet wide, 23 feet high, and mounted on a carriage. This movable bulkhead reaches to the bottom of the tank. The carriage oscillates horizontally on rails mounted on top of each wall of the tank. Top rails and dual spring-loaded wheels are used to prevent lifting of the carriage from the rails during operation. The oscillatory motion is transmitted to the bulkhead and carriage by two arms, 42 feet, 9 inches long, connected to two driving disks. Each disk is 19 feet in diameter and weighs 14 tons. The disks are driven through a train of gears by an 800-horsepower, variable-speed motor which is controlled from an observation room overlooking the wave tank. With one change of gears, a continuous range of wave periods between 2.6 and 24.8 seconds can be obtained. The maximum usable wave height is approximately 6 feet in an operating depth of 15 feet. Breakers as high as 7.5 feet have been observed on some test beaches and structures.



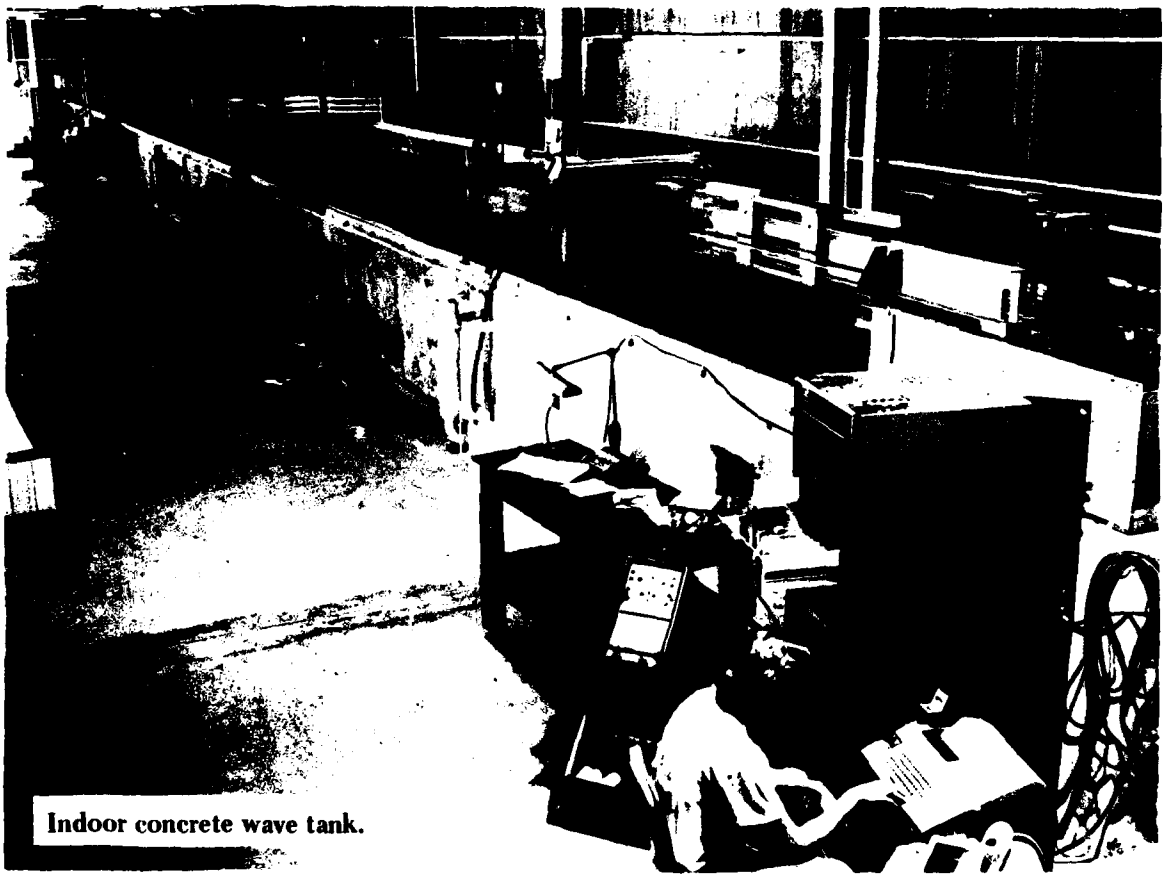
Motor, disks, and arms of the wave-generating mechanism for the large wave tank.

The bulkhead stroke can be varied from 2 to 17.5 feet by changing the eccentric setting of the connecting arms on the driving disks. The stroke setting may be varied in 3-inch increments through the range from 2 to 8 feet and in 6-inch increments from 8 to 17.5 feet. The lowest waves generated by the oscillatory motion of the bulkhead are about 2 feet for the shorter periods. For some tests, waves lower than 2 feet are desired for shorter wave periods. Consequently, the generative mechanism has been adapted to connect to a bulkhead hinged to the bottom of the tank to give waves with heights about one-half those available with the vertical bulkhead for the same period and eccentric setting.

Six-foot-high waves in the large wave tank.

INDOOR CONCRETE WAVE TANK

This reinforced concrete wave tank facility is 140 feet long, 15 feet wide, and 4 feet deep, and is located in the Jay V. Hall, Jr. Laboratory building. Experiments normally carried out in this facility can be considered as being performed at scales ranging from 1:10 down to 1:60. A few of the types of experiments conducted in this facility are: (a) determining wave runup for various structure cross sections as a result of irregular waves impinging on the structures; (b) determining wave transmission coefficients for various structure cross sections; and (c) determining wave forces and wave pressure distribution on the sloping face of rubble-mound breakwaters or revetments.



Indoor concrete wave tank.

The reinforced concrete tank is equipped with a manually operated instrument and personnel carrier which spans the tank and runs on tracks along its entire length. An electrohydraulic wave generation system provides for generating waves in water depths from 1 to 3.5 feet over a range of bulkhead amplitudes from 0 to 18 inches. Motion of the push-pull vertical bulkhead is governed by varying the input voltage to the system by means of a prerecorded magnetic-tape signal, or by a dedicated minicomputer which produces from one to six command signals simultaneously to allow generation of either regular or irregular waves.

A weir section located at the shoreward end of the tank is available for experiments where it is necessary to maintain a certain water level in that section of the tank while, at the same time, water is added or removed from the other section (e.g., simulating flow in and out of an inlet or river mouth).

SMALL WAVE TANKS

CERC has two tanks constructed of stainless steel with glass side panels. These tanks are used in a manner similar to the concrete wave tanks. Frequently, the tanks are used to duplicate experiments conducted in the large wave tank but at much smaller scales to determine scale effects. After the scale effects are known, testing at a smaller scale can proceed with confidence.

Stainless-steel, glass side wave tanks.

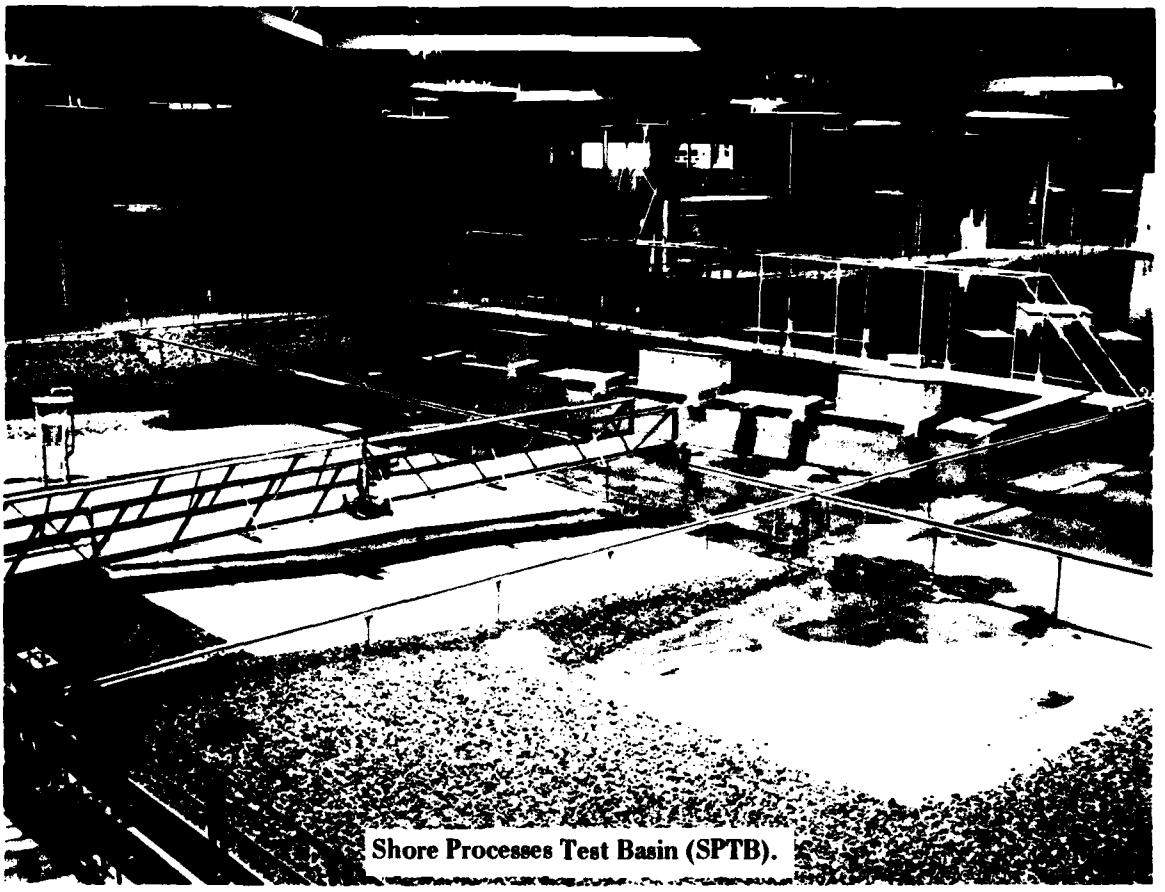
Survey measurements in the wave tank.

Both tanks are 150 feet long and 3 feet deep. They differ in width, one is 3 feet and the other is 1.5 feet wide. Level rails on each side of the tanks run their entire length and permit measurements from a level base and provide a track for various instrument carriages. Electrohydraulic wave generators are used in the tanks to produce regular monochromatic waves or irregular waves. The wave generators are controlled by a computer or magnetic tape.

SHORE PROCESSES TEST BASIN (SPTB)

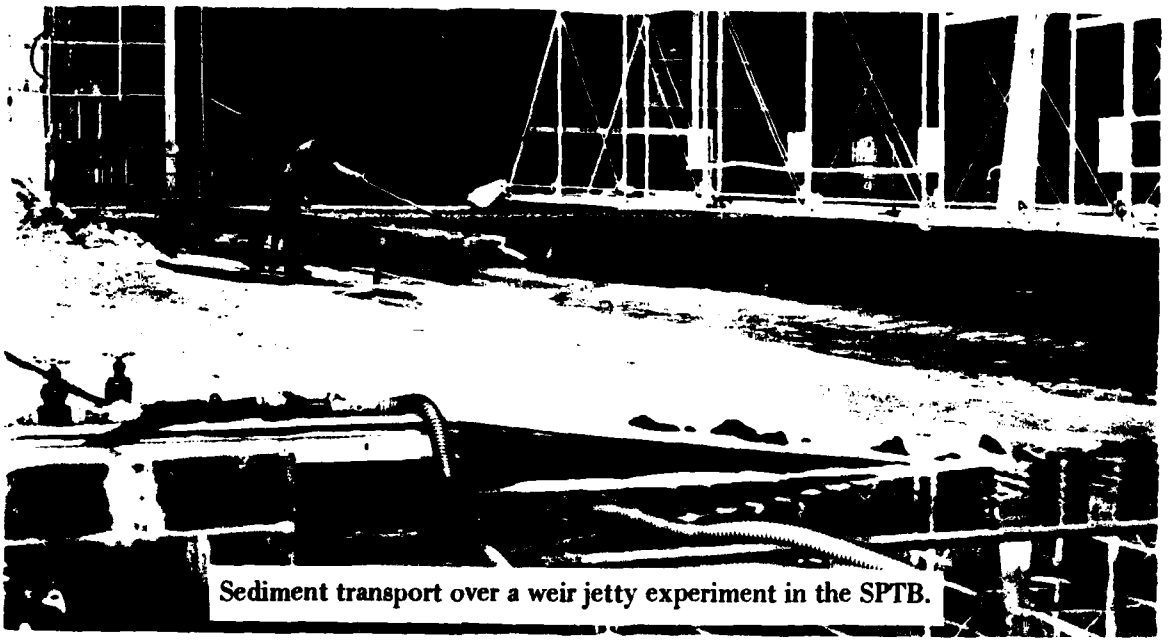
This basin is located in the Jay V. Hall, Jr. Laboratory building and is used to conduct experiments in the three-dimensional mode. Examples of experiments conducted in this facility are (a) determination of the longshore transport rates as a function of wave energy and direction, and (b) investigation of the behavior of weir jetty systems with regard to trapping and passing sediment at coastal inlets.

This concrete basin is 300 feet long, 150 feet wide, and 4 feet deep. The basin is constructed with a smooth, impermeable floor and vertical boundaries. Drains, fill lines, and power supply are located in the basin to permit partitioning into smaller, independent sections.



Shore Processes Test Basin (SPTB).

Six movable wave generators of the push-pull bulkhead-type are used. All have a bulkhead face width of 20 feet. Each generator is powered by a 7.5 horsepower, a.c. variable-speed electric motor drive and equipped with an 8-inch variable eccentric arm for changing the bulkhead stroke. The generators were designed to give a continuous range of wave heights up to about 8 inches in 2.5 feet of water, with a wave period range of 1 to 4 seconds. It is possible to divide the generators into two or more sets which may be operated independently to simultaneously produce separate wave trains with different characteristics. Operated independently, up to six wave trains of different heights, directions, and phase, and three different wave periods can be produced. All machines are operated and controlled from an elevated control room which overlooks the basin.



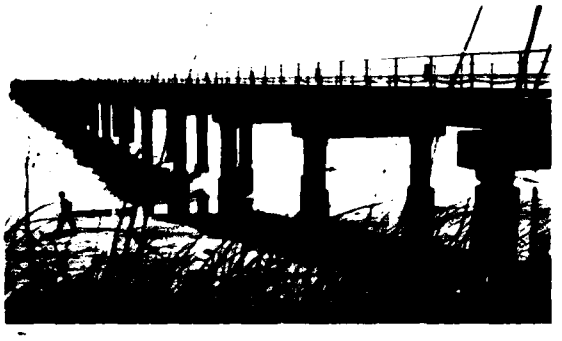
Sediment transport over a weir jetty experiment in the SPTB.

The basin is equipped with two motor-driven instrument and personnel carriers, 50 and 100 feet long, that can be arranged to facilitate different experiments when the basin is subdivided into more than one section.

Collecting sand for a sediment transport experiment.

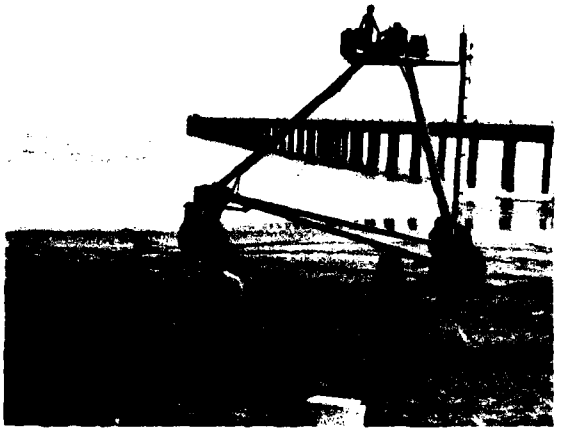
FIELD RESEARCH FACILITY (FRF)

Much of CERC's past coastal engineering research has been laboratory experimentation and theoretical investigations. Supportive fieldwork has been hampered by a lack of dependable means of obtaining high-quality wave, beach, and water level data, including data during storms. To overcome this deficiency, CERC has constructed a Field Research Facility on 175 acres at Duck, North Carolina, consisting of an 1,800-foot-long pier and accompanying laboratory building. The facility is designed to fulfill four major objectives:



Pier at the Field Research Facility, Duck, North Carolina.

(1) To provide a rigid platform from the land, across the dunes, beach, and surf zone out to the 20-foot water depth from which waves, currents, water levels, and bottom elevations can be measured, even during severe storms.



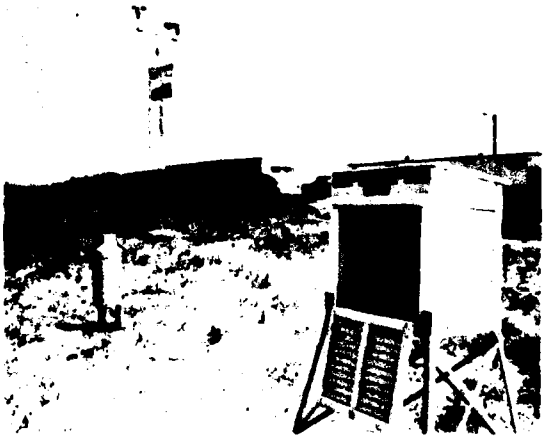
Surveying with the Coastal Research Amphibious Buggy.

(2) To serve as a permanent field base of operations for physical and biological studies of the site, the adjacent sound, bay, and ocean region by both CERC and other agencies and universities.

(3) To provide CERC with field experience and data that will complement laboratory and analytical studies and provide a better understanding of the influence of field conditions on measurements and design practices.

(4) To provide a manned field facility for testing of new instrumentation.

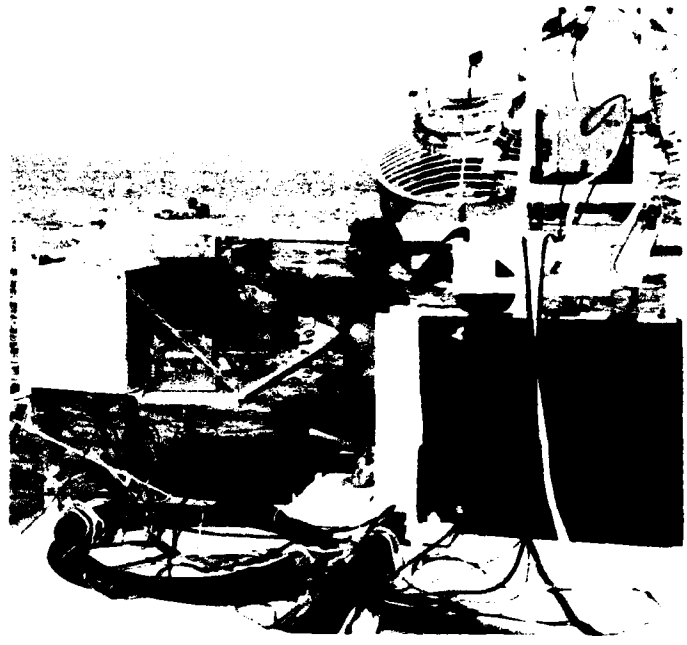
The research pier is a reinforced concrete and steel structure supported by 3-foot-diameter steel piles spaced 40 feet apart along the pier length and 15 feet apart across the width. The piles are embedded approximately 50 to 60 feet below the ocean bottom. The pier deck is 20 feet wide and extends from behind the dune line to about the 20-foot water depth, at a height of 25 feet above mean sea level. Concrete erosion collars protect the pilings against sand abrasion, and a cathodic system protects the pilings against corrosion.



Weather recording station.

The main building has 4,500 square feet of area which contains offices, an instrument repair shop, a vehicle shelter area, and visiting scientist accommodations.

A number of instruments located on or near the pier are used to routinely measure and record data on the meteorological and oceanographic conditions at the site. The National Weather Service collects and processes data on wind speed and direction, barometric pressure, precipitation, solar radiation, air temperature, and humidity. The National Ocean Survey collects and processes tide data. CERC collects and records data on wave and nearshore currents by various types of gages and visual observations. Additionally, periodic surveys of the ocean bottom and beaches are made at the facility and along adjoining shores. All wave and current data are electronically transmitted to CERC's headquarters at Fort Belvoir, Virginia, for recording and analysis.



Developing and testing new equipment for coastal research.

Monitoring data collection equipment.

CERC's Field Research Facility at Duck offers a unique opportunity to study coastal phenomena, and CERC encourages the use of the facility by outside investigators.

TECHNICAL SUPPORT

AUTOMATIC DATA PROCESSING OFFICE

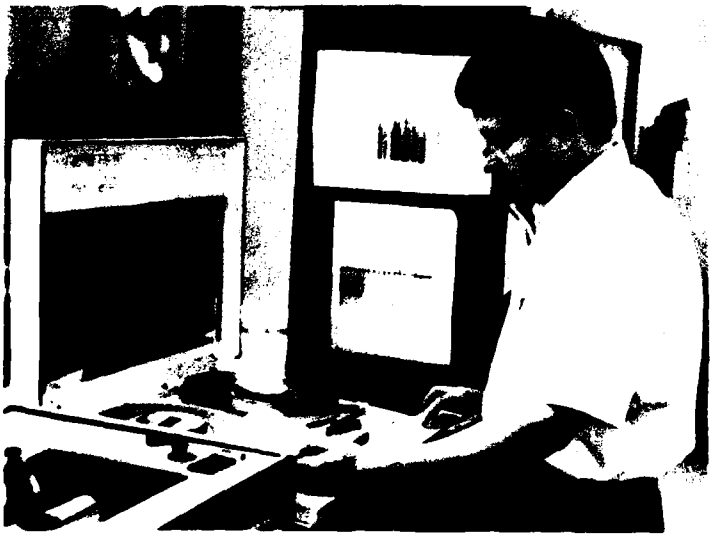
An ever-increasing number of engineering problems are being computerized and the computer has become an invaluable tool in both the research and the engineering communities.

The Automatic Data Processing (ADP) Office provides computer services to support CERC's research and development program and finance and accounting needs.

The office designs and develops data processing software systems, develops computer programs, maintains CERC's library of computer programs, operates CERC's computer terminals and peripheral equipment, coordinates computer-related activity between CERC and other agencies, and advises and assists CERC managers, scientists, and engineers in the development and application of computer software.

Computer tape storage room.

CERC currently obtains the majority of its computer support through the use of a Harris Communications, Inc., COPE 1200 remote batch computer terminal which is linked via telephone lines to a variety of host computers nationally. The COPE 1200 consists of a 12K memory, keyboard printer console, 600 card-per-minute reader, 700 line-per-minute printer, two magnetic-tape drives, 200 card-per-minute card punch, and a digital incremental plotter.



Tape drive for the COPE 1200.

In addition to the COPE 1200, computer services are provided for interactive data processing applications on a CDC 6600 computer and other large-scale digital computers via an ASR 33 teletype and Tektronix 4006 and 4015 graphics display terminals.

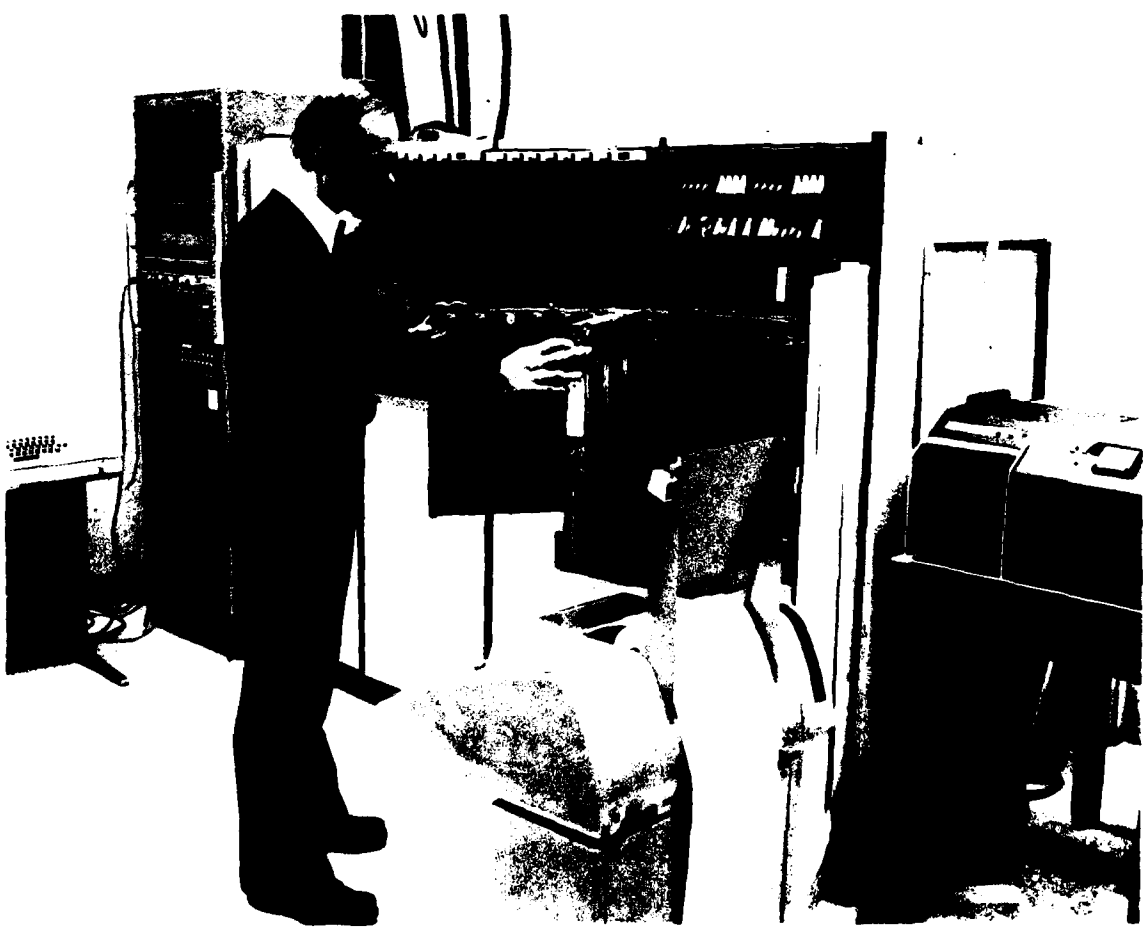
A Programing Language (APL) service is provided to CERC researchers through contract with a commercial firm. APL is a high-level programing language which is ideal for developing sophisticated mathematical algorithms. APL is used interactively through portable DATEL terminals and the Tektronix 4015 graphics display terminal.

Continuous Line Digitizor.

The ADP Office also operates CERC's Data Acquisition System (DAS). The DAS provides automated real-time process control for the collection of laboratory data and control of laboratory equipment under programable computer command. The system has a 32 channel analog-to-digital converter with a range of ±10.24 volts having an accuracy of 5 millivolts. To ensure precise time sampling, a sample and hold feature holds the input signal at its instantaneous level until it has been converted to a digital signal. An Input/Output Interface Subsystem (IOIS) is also available. Provided with the IOIS is a digital-analog converter which converts digital information into an analog voltage ranging between ±10.24 volts with a maximum of 1/2 ampere output. Digital-to-analog conversion permits the DAS to be used to control various types of laboratory equipment such as wave generators permitting the creation of desired wave conditons. An interval timer may also be added to the IOIS to indicate the passage of time in intervals of 5, 10, 20, 50, or 100 microseconds.

Storage devices include a 1 mega-word disc available for temporary storage, and two seven-track magnetic-tape units. A card reader permits punchcard input at the rate of 300 cards per minute, a line printer provides output at the rate of 300 lines per minute, and an ASR-33 teletype provides for keyboard and paper-tape input and output.

The Central Processing Unit (CPU) of the system and associated hardware control the above-mentioned devices. Computer capabilities such as a FORTRAN IV compiler, assembler, catalog and other operations associated with general batch computers are also available. The system software provides for running many programs simultaneously while sharing the CPU in a defined, orderly manner. Also, programs can be automatically activated at specified times of day or when specific events occur. With these features, many experiments can be conducted concurrently under control of the DAS with their activation controlled by either time of day, elapsed time, or the occurrence of a specific event in laboratory experiment or the natural environment in field projects.



Data Acquisition System (DAS).

INSTRUMENTATION AND EQUIPMENT LABORATORY

CERC's Instrumentation and Equipment Laboratory contains equipment, space, and staff for the fabrication, calibration, and maintenance of equipment required to collect field and laboratory data in support of the coastal engineering research program. Available equipment includes wave gages, telemetry systems, analog and digital tape recorders, bottom sediment samplers, wind recorders, and instruments for topographic and hydrographic surveying. A special test facility room is available for tests such as laser testing and other instrument development where isolated testing is required.

Instrumentation and Equipment Laboratory.

Photographic Laboratory.

PHOTOGRAPHIC LABORATORY

CERC's photographic laboratory supports the various laboratory tests and other activities of the Center by preparing photographic illustrations of laboratory setups, obtaining photographic data in laboratory tests, and preparing graphics for presentation by CERC staff.

PETROLOGY LABORATORY

The petrology laboratory is equipped to determine sediment granulometric characteristics and parameters, mineralogic composition, sediment specific gravity, and laboratory detection of radioactive and fluorescent sediment tracer particles. Other miscellaneous routine chemical procedures can also be accomplished.

Petrology Laboratory.

SUPPORT BRANCH

The Support Branch operates and staffs a complete and fully equipped group of shops that make the Center nearly self-sufficient with respect to carpentry, electrical, mechanical, plumbing, welding, concrete, and automotive work.

Automotive Shop.

Carpentry Shop.

DRAFTING BRANCH

The Drafting Branch provides cartographic and drafting services for the Center and is responsible for preparing layout and mockup of CERC's reports preparatory to publication.

Drafting Branch.

PUBLICATIONS BRANCH

The Publications Branch is responsible for reviewing, editing, preparing in reproducible form, and initial distribution of all technical manuscripts resulting from research projects under CERC's direction. The Publications Branch is also responsible for arranging publication exchange agreements with foreign institutions engaged in similar work.

Magnetic-Tape, Selectric Typewriter (MT/ST).

COASTAL ENGINEERING INFORMATION AND ANALYSIS CENTER (CEIAC)

Processing information requests.

This Coastal Engineering Information and Analysis Center is responsible for storage and dissemination of data related to coastal engineering and replying to requests for information. CEIAC is responsible for furnishing on request to other Government agencies and the general public the CERC publications remaining after the initial distribution by the Publications Branch as long as the supply lasts.

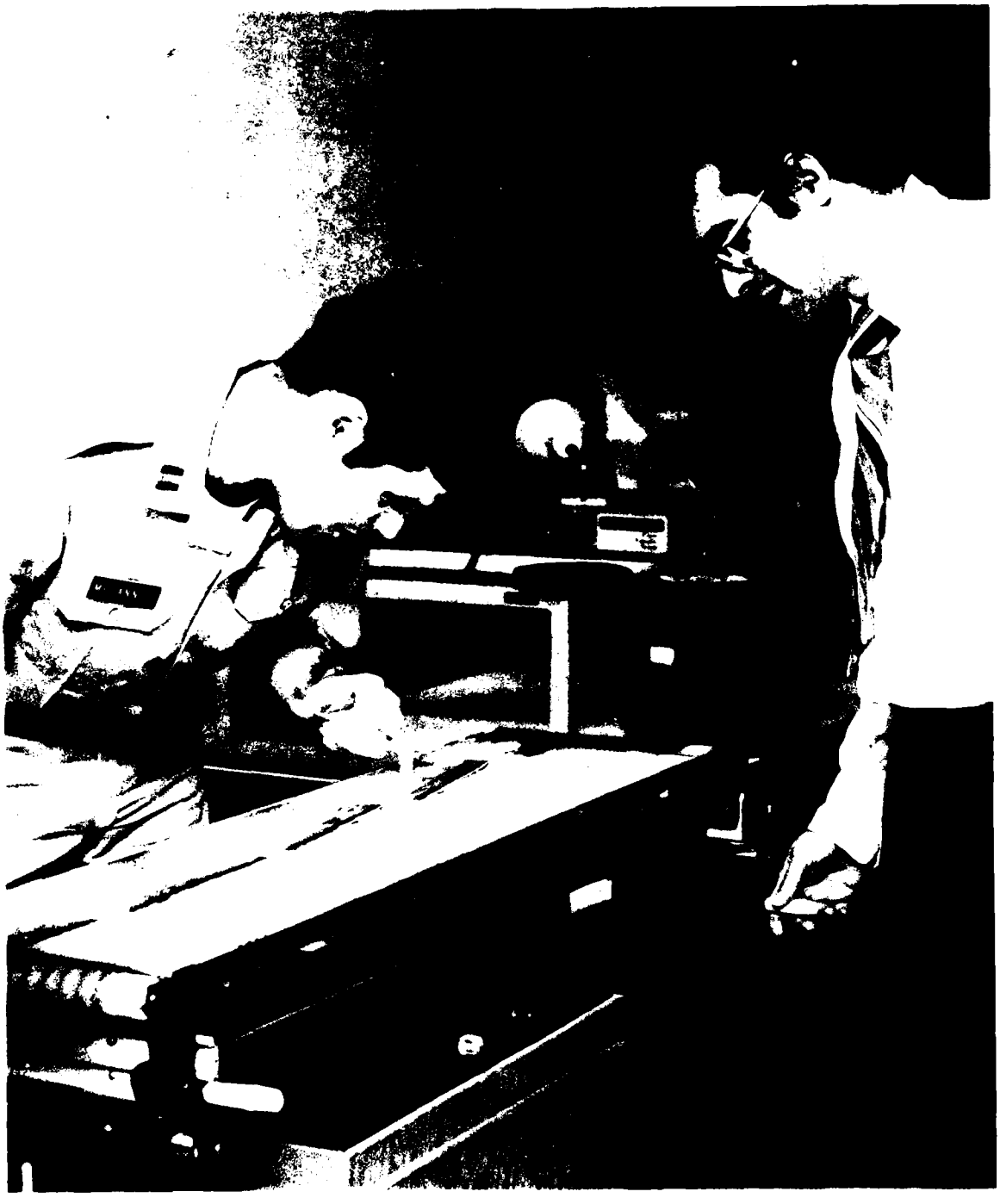
LIBRARY

CERC's library provides a full range of library services and technical literature resources. The collection is the result of the amalgamation of the collections of the Coastal Engineering Research Center, the Water Resources Support Center (WRSC), and the Board of Engineers for Rivers and Harbors (BERH) and serves as a central source of technical information in those engineering scientific fields in which the CERC, BERH, and WRSC have an interest.

Library reception desk.

Library reference files.

The collection is one of the nation's most extensive in subject matter areas of coastal engineering, consisting of approximately 40,000 books, 63,000 reports, 5,000 periodicals, and 3,100 microforms. In addition to normal acquisitions by gift or purchase, the collection is kept current by exchanges with leading engineering, scientific, and educational institutions both in the United States and abroad. It is staffed by professional librarians, and can supply (on loan) out-of-print publications of CERC and the Beach Erosion Board.



REMOTE SENSING

The Remote Sensing research program evaluates and tests the application of remote sensing technology for coastal engineering and provides advice for the implementation of remote sensing to the coastal engineering research program and coastal projects.